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Integrated Pest Management (IPM) in the Vegetable Industry During the 1980's

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Abstract

Integrated pest management (IPM) has become especially important for vegetable crops because of increased public pressure to reduce pesticide use on these crops. The funding and adoption of IPM programs for vegetable crops during the 1980's are examined in this report. Vegetable IPM usage statistics are based on data from annual State-level Extension Service reports, which are mandated for federally funded extension IPM programs. According to these reports, both vegetable IPM funding and acreage increased dramatically during the 1980's.

Keywords: Integrated pest management, IPM, vegetables, pesticides.

Acknowledgments

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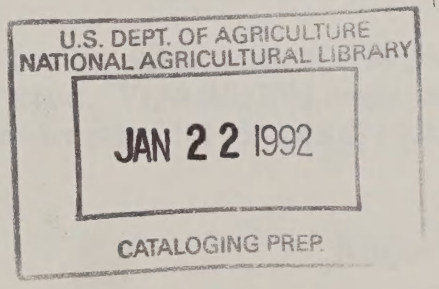

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Integrated Pest Management (IPM) in the Vegetable Industry During the 1980's

Catherine R. Greene
Gerrit W. Cuperus[1]

Introduction

Interest in integrated pest management (IPM) for vegetable crops increased during the 1980's. The IPM approach reduces pesticide use by combining several control techniques and has become popular with vegetable producers for several reasons. Vegetable growers have been experiencing increased public pressure to reduce pesticide use, and changing State and Federal legislation has resulted in fewer chemical options available to them. Also, pests of certain vegetable crops have developed resistance to all pesticides registered for use on those crops. Growers may also have an economic incentive to use IPM because crop yield and quality are maintained, and input costs are often lowered.

IPM research originally focused on field crops, including corn, soybeans, cotton, alfalfa, grain sorghum, and peanuts, where the largest volume of pesticides was used. The development and adoption of IPM practices for these crops have been widely documented (*17*).[2] Some authors indicate that adoption of IPM practices resulted in decreased pesticide use on these crops since the early 1970's (*3*).

A congressionally-mandated objective of State IPM programs receiving Federal funds is to reduce pesticide use, minimize environmental contamination, and reduce pesticide exposure to farmworkers. The focus of vegetable IPM programs in most States has been primarily on pest scouting and monitoring which reduces, but does not eliminate, pesticide application. The focus is gradually broadening to include cultural, biological, and other nonchemical management practices, which reduce or prevent damaging pest populations.

The funding and adoption of IPM programs for vegetable crops during the 1980's are examined in this report. Vegetable IPM usage statistics are based on annual State-level Extension Service reports, which are mandated for federally funded extension IPM programs.

Major Crops and Production Areas

California and Florida are the most important vegetable-producing areas in the United States, with $3.7 billion and $1.5 billion in cash receipts from the sale of fresh and processing vegetables, dry

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[2]Italicized numbers in parentheses are listed in the References section at the end of this report.

beans, and potatoes in 1989. California and Florida supplied 54 and 12 percent of total U.S. fresh vegetables in 1989, followed by Arizona (6 percent), Texas (4 percent), and Oregon (3 percent). California was also the top processing State with 60 percent of the total production, followed by Wisconsin (9 percent), Minnesota (6 percent), Oregon (5 percent), and Washington (4 percent).

Among the fresh-market vegetables, tomatoes had the highest value of production in 1989 at $1.2 billion, followed by lettuce ($950 million) and onions ($502 million) (*14*). Other major fresh vegetables are asparagus, broccoli, carrots, cauliflower, celery, and sweet corn, which range between $150 million and $300 million in value. Tomatoes were also the most highly valued processing vegetable crop in 1989, at $640 million, followed by snap beans, sweet corn, cucumbers, and green peas, which were each valued between $100 million and $200 million in 1989.

Potatoes and dry beans are two other major vegetable crops that are estimated and reported as field crops. Potatoes were worth $2.5 billion and dry beans were worth $680 million in 1989 (*15*). The major potato-producing States in 1989 were Idaho, with 28 percent of total production, and Washington, with 17 percent; Colorado, Maine, Oregon, and Wisconsin each accounted for about 6 percent.

Vegetable Pesticide Use

The use of synthetic organic pesticides became widespread on vegetable crops soon after their introduction in the 1940's, even before their use became well established on major field crops (*9*). By 1952, 61 percent of the U.S. vegetable acreage and 75 percent of the potato acreage was treated with insecticides (fig. 1). In contrast, insecticide use was 1, 47, and 48 percent on field corn, tobacco, and cotton acreage and was not reported on other field crops in 1952.

The most recent national survey of pesticide use on vegetables showed that 74 and 84 percent of the acreage was treated with insecticides and herbicides in 1979 (*5*).[3] A more recent survey (1988) on potatoes showed that 62, 77, and 89 percent of the acreage received fungicide, herbicide, and insecticide treatment (*13*).

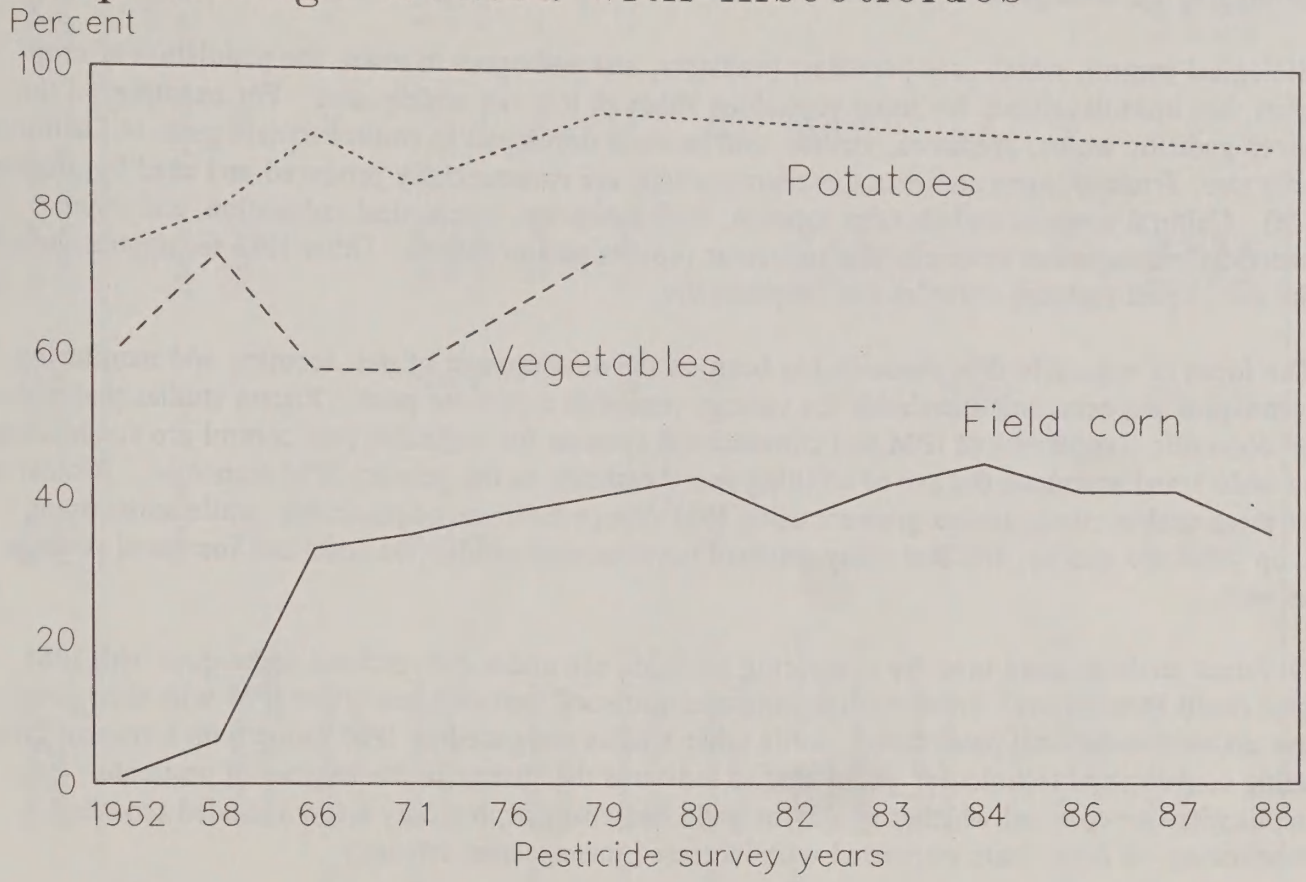
Climatic conditions are the primary factor regulating pest populations. Areas with warm, humid conditions will normally require significantly more pesticide use. Northwest vegetable growers, for example, had 17 percent of the total vegetable acreage in 1979, but applied only 6 percent of the total acre-treatments (acres treated once by a specific pesticide). Southeastern growers, with only 19 percent of the acreage, applied 43 percent of the acre-treatments. The hot, humid climate of Florida, Georgia, and other Southeastern States exacerbates insect, disease, and other pest problems in those States. Also, production of fresh-market tomatoes, which are particularly susceptible to pest damage and require proportionally greater use of pesticides, is concentrated in Florida.

Pest problems can also vary considerably within a State whose regions have different climatic conditions. For example, 60 percent of the California processing tomato growers reported that weeds were their worst problem, followed by insects (19 percent), diseases (19 percent), and nematodes (2 percent) (*16*). Although weeds were the biggest problem in the Sacramento and San Joaquin Valleys,

[3]The 1979 vegetable pesticide survey included 18 States in 5 regions: Northeast (New York, New Jersey), Southeast (North Carolina, South Carolina, Georgia, Florida), Midwest (Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin), Northwest (Idaho, Oregon, Washington), and Southwest (Arizona, Colorado, Texas). California was not included because that State conducts its own annual pesticide survey, although not all pesticide use was reported prior to 1990.

Figure 1

Crop acreage treated with insecticides



insects were 100 percent of the pest problem in the southern desert, and insects and diseases combined accounted for 100 percent in the southern coast.

Different vegetable crops also vary in their susceptibility to insect, disease, and other crop pests. For example, tomatoes accounted for only 6 percent of the total U.S. vegetable acreage in 1979 but received 26 percent of the acre-treatments. Conversely, green peas were 18 percent of the total acreage but received only 5 percent of the acre-treatments. Cabbage, carrot, celery, and onion acreage received relatively heavy pesticide treatment, while cucumber and snap bean acreage was treated less heavily.

The type of pest problem to which different vegetable crops are most vulnerable also varies. Green pea growers, for example, reported no use of fungicides in 1979, indicating that they had no problems with disease. For lettuce growers, insects were the worst problem, with insecticides accounting for over half of the total pesticide applications on that crop.

Pest Management Systems

Before the widespread availability of synthetic organic pesticides, methods to control agricultural pests focused on field sanitation, planting date, crop rotation, and other physical and cultural controls, and the use of inorganic pesticides (*9*). Conventional pest control for vegetables since that time has usually focused on the use of synthetic organic pesticides on a routine (calendar or pest-growth stage) basis, because these pesticides are relatively inexpensive, easy to apply, and effective.

IPM differs from both organic and conventional pest control. While organic control excludes chemical pesticide use and conventional control uses routinely applied pesticides, IPM combines the use of pesticides based on economic threshold levels[4] with biological, cultural, and other nonchemical techniques and management practices.

Biological control, which uses parasites, predators, and pathogens to lower the population of crop pests, has been developed for some vegetables although it is not widely used. For example, of the seven parasitic wasps, predators, viruses, and bacteria developed to control tomato pests in California, only two, *Trichogramma* and *Baccilus thuringiensis*, are commercially produced and used by growers (*16*). Cultural controls include crop rotation, field sanitation, mechanical cultivation, and other beneficial management practices that reduce or prevent pest problems. Other IPM techniques include the use of pest-resistant varieties and biopesticides.

The focus of vegetable IPM research has been on the development of pest scouting and monitoring techniques and economic thresholds for various vegetable crops and pests. Recent studies that make an economic comparison of IPM and conventional systems for vegetable pest control are summarized in table 1 and examined the use of scouting and thresholds as the primary IPM technique. Almost all of these studies conclude that growers using IPM reduce their use of pesticides, while maintaining crop yield and quality, and that many growers have reduced production costs and increased revenue as well.

Different methods were used for comparing pesticide use under conventional techniques with IPM pest control techniques. Some studies compared growers' pesticide use under IPM with their previous use under conventional pest control, while other studies compared an IPM group with a control group using conventional techniques. Most studies indicated the change in the number of pesticide applications or cost and whether quality or yield had changed, but only a few included scouting, monitoring, or other costs associated with increased management intensity.

Also, these studies did not indicate the total change in pesticide use for the groups, and, in a few cases, use of other types of pesticides may rise with IPM. For example, one of the vegetable IPM programs in Florida, a State with especially large pest problems, reduced the use of insecticides, fungicides, and herbicides but increased the use of fumigants (*8*).

Most States have indicated in their annual Extension Service IPM reports that implementation of vegetable IPM programs resulted in decreased pesticide use. Although research on vegetable IPM suggests that pesticide use is reduced substantially with the use of economic thresholds and other IPM techniques, there is little pesticide use data to document change.

Potatoes are the only vegetable crop that has been surveyed concerning pesticide use at the national level since the late 1970's.[5] Potato acreage treated with insecticides showed a 5-percent decline between 1978 and 1988 (the last 2 survey years), and insecticide use was reduced in five of the top six potato-producing States (fig. 2). Potato acreage treated with fungicides also showed a small decline (3 percent) between 1978 and 1988.

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[4]Pest populations are scouted or monitored, and pesticides are applied only when pest levels exceed an economically damaging threshold level.

[5]The same 11 major potato-producing States were surveyed in both 1978 and 1988: Colorado, Idaho, Maine, Michigan, Minnesota, New York, North Dakota, Oregon, Pennsylvania, Washington, and Wisconsin.

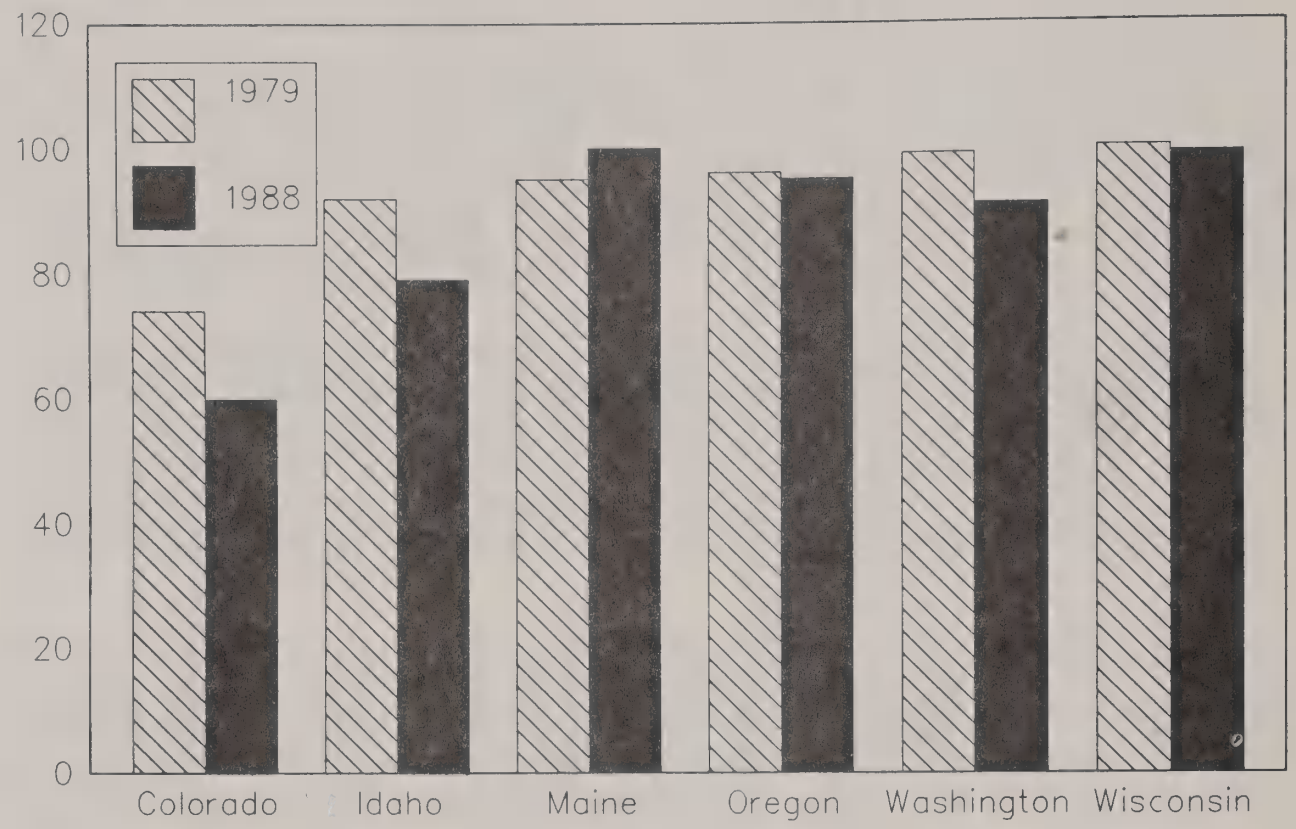
Table 1--Recent studies comparing costs and benefits of IPM and conventional pest control

Author (see References)	Year	State	Commodity	Acres	Growers	IPM technique	Comparison method	IPM group	Control pre-IPM	Reduction in IPM users' pesticide cost		IPM costs	Quality or yield change
				- - *Number* - -				*Number of sprays*		*Dollars*	*Percent*	*Dollars per acre*	
Adams	1989	CT	Sweet corn	182	--	Integrated insect control	IPM growers/ non-IPM growers	--	--	2,913	78	--	Increase
Antle and Park	1984	CA	Processing tomatoes	2,000	56	Economic thresholds for two insects	IPM growers/ control group	--	--	0	22	0.58	Increase
Coli	1985	MA	Potatoes	2,100	103	Economic thresholds for two insects	IPM growers/ control group	4.4	7.5	96,536	--	4.00	Increase
	1986							5.7	7.5	for all	--	4.00	Increase
	1987							4.9	7.5	3 years	--	4.00	Same
Coli	1987	MA	Sweet corn	1,200	19	Economic thresholds for three insects	IPM growers/ control group	--	--	2,000	--	--	--
Frisbie	1987-88	TX	Processing carrots	720	--	Economic thresholds for one insect	Previous contract required 6 sprays	2.0	6.0	21,600	66	--	Same
Frisbie	1987-88	TX	Cabbage	--	--	Economic thresholds for one insect	Growers with IPM/ non-IPM fields	8.0	14.0	--	43	--	--
Pohronezny	1984-85	FL	Tomatoes	25,995	--	Economic thresholds insects and disease	Survey respondents using/not using commercial scouts	--	--	121/ac	25	--	Increase
			Peppers	2,550	--			--	--	95/ac	50	--	Increase
			Snap beans	8,630	--			--	--	95/ac	10	--	Increase
Toscano and others	1980-81	CA	Fresh tomatoes	--	--	Economic thresholds:	IPM growers/ control group						
						Fruitworm		5.5	6.5	--	--	--	Same
						Pinworm		1.0	1.3	--	--	--	Same
						Beet army worm		3.7	6.7	--	--	--	Same
Welty	1989	OH	Processing cabbage	--	3	Economic thresholds for three insects	Growers with IPM/ non-IPM fields	--	--	--	25-50	--	--
Wright and others	1984, early	NY	Fresh potatoes	--	--	Economic thresholds for several insects	IPM growers/ control group	6.2	9.3	58/ac	--	8.00	Same
	late			--	--			6.9	8.8	31/ac	--	8.00	Same
	1985, early			--	--			4.8	7.0	38/ac	--	8.00	Same
	late			--	--			7.8	6.9	31/ac	--	8.00	Same

-- = Not available.

Figure 2

Fall potato acreage treated with insecticides



Since 1978, predictive models for potato blight and economic thresholds for various potato insect pests have been developed in many of the important potato-producing States, and adoption of these IPM techniques may be one of the factors that contributed to the small decline in insecticide and fungicide use. Herbicide use went up slightly (5 percent) between these 2 survey years, and the development of many new herbicides during this period may have influenced use.

Annual Extension Service IPM Reports

The U.S. Department of Agriculture's (USDA) Extension Service receives a report each year that describes the accomplishments of federally funded IPM programs. This report must be prepared for each State's IPM program, which is funded entirely or in part by nonformula Federal funds. Nonformula Federal funds are appropriated annually by Congress to respond to high-priority needs and are required to be auditable (*19*).

The IPM accomplishment report also includes a statistical table (table IV) describing IPM program costs, acres, extension staff, and numbers of clients and providers served by various IPM programs (fig. 3). USDA's Extension Service collects these statistics and other information in the IPM reports in order to monitor the use of IPM funds and assess progress in achieving program goals. State IPM extension specialists and other extension specialists complete the annual IPM reports.

Table IV statistics on IPM funding, acreage, and numbers of IPM clients and providers may underestimate the actual numbers in two ways. First, because States are required to report only on the IPM vegetable programs that are partly or entirely federally funded, programs that are wholly State or industry funded may not be reported. In California, only the tomato IPM program is

Figure 3
Extension Service annual IPM report

Table IV
Integrated Pest Management Report
FY _____
State _____

	Commodities of Other Project Designations					
	1.	**2.**	**3.**	**4.**	**5.**	**Total**
Program Costs ($):						
1.Smith-Lever3(d)_____						
2.Other CES Funds_____						
3.Grower Payments to _____						
a.Extension Programs _____						
b.Private Consultants/firms ____						
c.Grower Organizations/co-ops _						
4.Others_____						
Acres or Units Handled by:						
1.Extension Sponsored Programs_						
2.Private Consultants/firms _____						
3.Growers Organizations/co-ops__						
4.Industry Fieldmen_____						
5.Others Influenced by Extension_						
CES Staff-Years:						
1.State Specialists_____						
2.Multi-County Staff_____						
3.County Staff_____						
Number of Scouts Trained: ____						
Number of Producers Trained:__						
Number Providing IPM Service:						
1.Extension Sponsored Programs__						
2.Private Consultants/firms _____						
3.Growers Organizations/co-ops__						
4.Industry Fieldmen _____						
5.Others Influenced by Extension_						
Number of Clientele Served:						
1.Extension Sponsored Programs_						
2.Private Consultants/firms_____						
3.Growers Organizations/co-ops__						
4.Industry Fieldmen_____						
5.Others Influenced by Extension _						
State Advisory Committee:						
1.No. People on Committee _____						
2.No. Agencies and Departments Represented_____						
3.No. Times Committee Met____						

reported in table IV, because it is the only program receiving nonformula Federal funds. However, a recent University of California statewide IPM project report indicates that IPM research was funded for asparagus, cucumbers, and lettuce, as well as tomatoes (*6*).

Second, extension specialists have actual data on the amount of State and Federal IPM funds and extension IPM acreage, clients, and providers, but the comparable figures for industry are estimated. Some specialists may not have information on the total number of private IPM consultants, firms, grower organizations, co-ops, and industry fieldmen in their State.

Another possible source of bias in the table IV statistics may be a lack of consistency between States in reporting. For example, a specialist in one State may interpret "Acres Handled by Extension Sponsored Programs" as just those acres under an IPM demonstration project, while another might include all the acres in the State where producers have been exposed to extension media related to IPM.

Specialists reported that IPM programs were developed for at least 30 vegetable crops during the 1980's, including asparagus, beets, broccoli, cabbage, cantaloup, carrots, collards, cucumbers, dry beans, eggplants, green peppers, lettuce, lima beans, malanga, okra, onions, potatoes, snap beans, southern peas, squash, sweet corn, sweet potatoes, tomatoes, and turnips. Some States aggregated the vegetables they reported, so there also may be programs for vegetables not on this list.

Most of the major vegetables (including tomatoes, lettuce, onions, dry beans, and potatoes) are on this list. However, the IPM programs for some of these vegetables are not necessarily in the primary producing States.

Federal, State, and Industry Funding

Combined Federal, State, and industry funding for vegetable IPM programs has risen dramatically from $64,213 in 1978 to $2.8 million in 1989, signaling progress in vegetable IPM research and use (fig. 4). Although IPM programs for major field crops have been developing for more than a dozen years, many States began development of vegetable IPM only during the 1980's. Also, growers have begun adopting vegetable IPM more rapidly during the past several years.

A major shift toward industry and State funding also took place during the 1980's. In 1984, Federal funds were 49 percent of total vegetable IPM funding, with industry and State funds accounting for 38 and 13 percent (fig. 5). By 1989, industry accounted for 67 percent of funding, while Federal funding declined to 17 percent and State funding increased slightly to 16 percent.

Federal funds remained fairly constant at about $0.5 million during this period, while State funds tripled to almost $0.5 million in 1989 and industry funds quadrupled to $1.9 million (table 2). Federal IPM funding for all commodities has also been fairly constant during the 1980's at approximately $7 million, with vegetable IPM averaging about 8 percent of total funding.

Federal and State funds are used for basic scientific research, development of economic thresholds, resistant varieties, biological controls, other IPM practices, and for projects to implement commercial use. Industry funds generally represent grower payments for IPM services, such as scouting, and include payments to grower cooperatives private IPM consultants and firms, and the Extension Service. Grower payments to the Extension Service are frequently pooled with Government funds to cover both research and implementation.

Figure 4

Vegetable IPM program funding

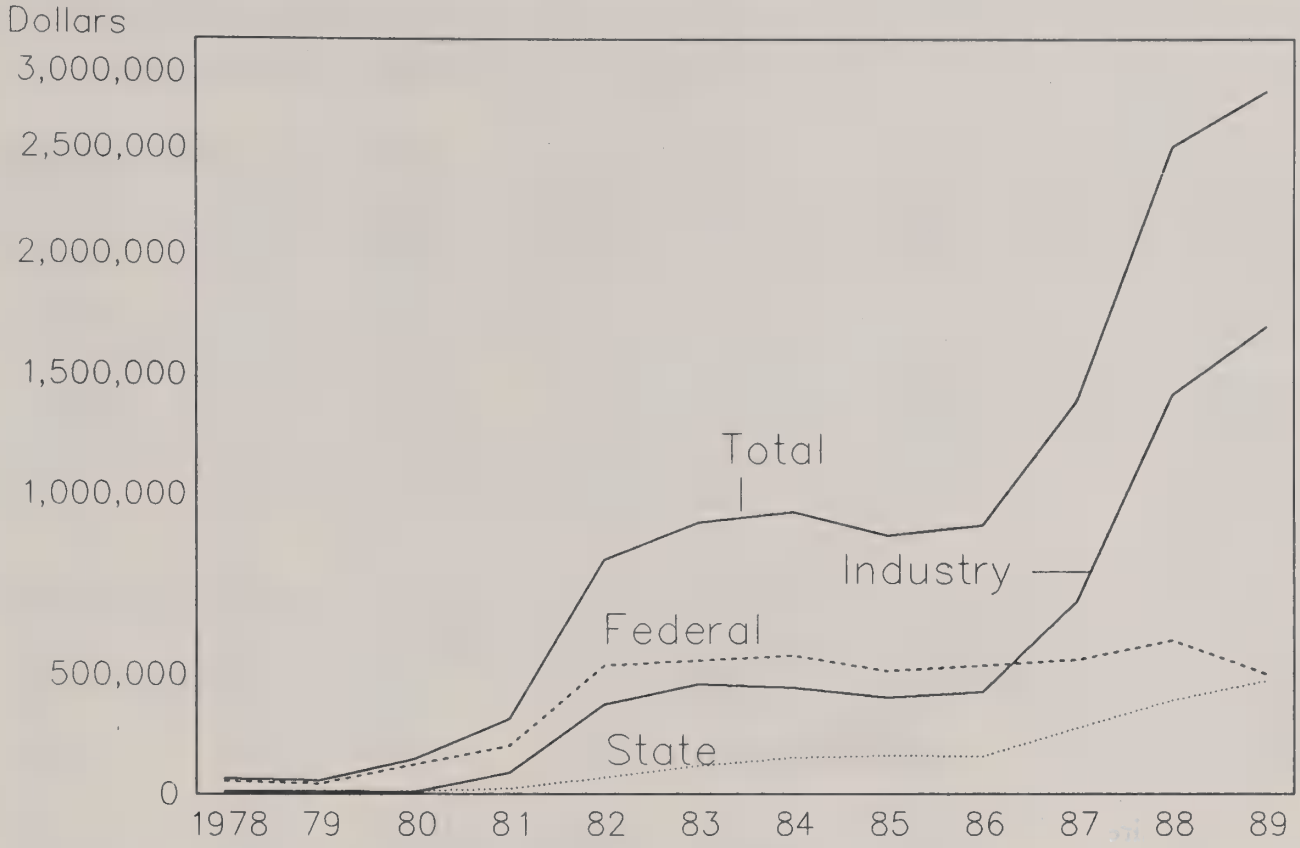


Figure 5

Vegetable IPM funding shifts toward industry

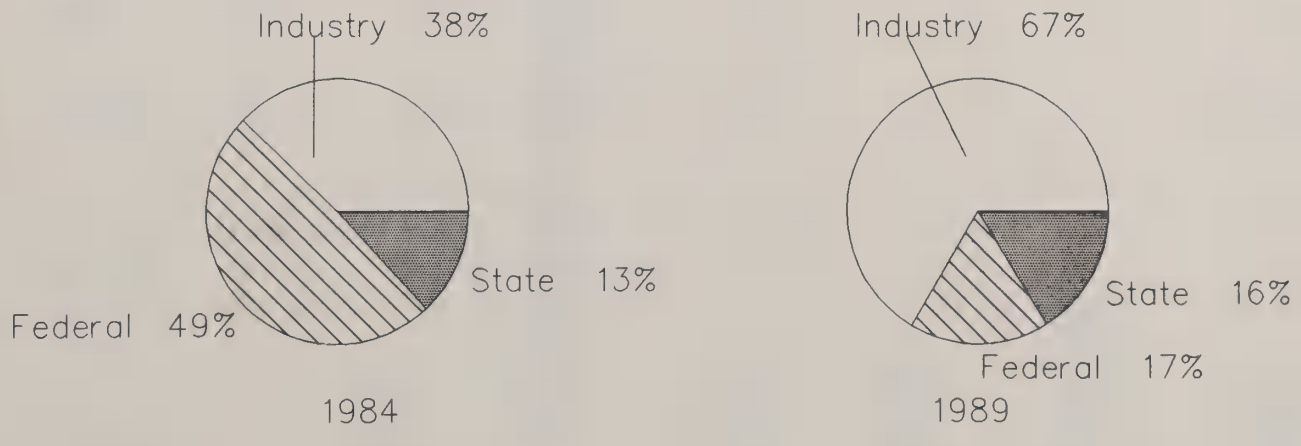


Table 2--Trend for vegetable IPM projects receiving Federal funds[1]

State	1984	1985	1986	1987	1988	1989
			Dollars			
Alabama	NR	NR	NR	NR	33,700	38,000
California	72,000	80,402	80,402	NR	207,900	187,100
Colorado	NR	36,000	28,000	27,500	17,000	58,000
Connecticut	29,715	27,000	20,577	21,033	21,434	45,900
Delaware	NR	10,600	7,000	14,488	106,567	109,431
Florida	215,000	120,263	33,000	423,760	963,500	1,039,000
Georgia	79,000	155,637	124,772	166,948	132,412	195,317
Idaho	39,000	24,650	54,450	54,350	54,350	58,325
Kentucky	NR	NR	6,400	20,750	20,000	NR
Massachusetts	NR	NR	65,720	40,180	NR	33,799
Maryland	NR	92,000	109,500	109,000	127,000	140,400
Maine	154,000	166,820	161,432	186,178	175,400	184,300
Michigan	49,000	NR	33,357	NR	NR	NR
Missouri	NR	NR	12,645	NR	NR	NR
North Dakota	13,000	22,600	27,100	33,600	31,600	27,000
New Hampshire	13,000	NR	15,000	13,000	11,000	10,000
New Jersey	73,000	66,000	87,000	157,750	195,250	129,660
Nevada	5,000	NR	NR	NR	NR	NR
New York	97,000	99,890	78,526	90,000	172,000	299,285
Ohio	NR	NR	NR	NR	13,624	17,050
Oklahoma	NR	NR	10,000	10,000	38,000	69,000
Oregon	68,000	9,000	14,000	NR	106,936	71,461
Rhode Island	28,000	30,000	27,286	19,381	NR	NR
South Carolina	65,000	50,653	33,000	NR	NR	55,000
Tennessee	NR	NR	NR	NR	NR	NR
Texas	NR	NR	NR	20,000	20,000	20,000
Vermont	4,000	NR	NR	NR	NR	NR
Washington	19,000	36,500	41,500	28,107	30,074	29,305
Wisconsin	NR	NR	NR	118,000	118,000	160,000
U.S. total	1,122,715	1,028,015	1,070,667	1,566,025	2,595,747	2,791,456
Federal	550,715	490,072	510,979	534,879	611,891	479,974
State	147,000	153,372	152,877	263,149	373,541	452,496
Industry	425,000	384,571	406,811	767,997	1,590,315	1,858,986

NR = Not reported.

[1]Includes Federal funds, State Cooperative Extension Service funds, and grower payments to extension, private consultants, and grower organizations.

Although industry funds in the extension report mainly reflect payment for services, private industry also conducts IPM research. IPM consulting firms may develop their own economic thresholds and other techniques. U.S. vegetable processors conduct research on pest-resistant varieties, cultural practices, and other products and management practices to reduce chemical dependence in the production process. Also, U.S. corporations are working on a wide array of alternative products, including biopesticides and genetically engineered pest-resistant varieties, which are congruent with the IPM philosophy to reduce dependency on synthetic pesticides.

The number of States with vegetable IPM programs increased from only a few prior to the early 1980's to 17 in 1984 and 22 in 1989. IPM funding in nine of these States (California, Delaware, Florida, Georgia, Maryland, Maine, New Jersey, New York, and Washington) was over $100,000. IPM funding increased in all of the top six IPM-funded States between 1984 and 1989 (fig. 6).

States are ranked according to their 1989 vegetable cash receipts in table 3. Eight out of the top 10 States reported having a vegetable IPM program in 1989. Arizona, which ranked eighth and is especially important in fresh winter vegetables, did not have an IPM program in 1989. Arizona's climate makes vegetable pest problems somewhat less severe than in many other States. Also, IPM resources in this State have previously been focused on cotton and other resources.

Michigan, ranked ninth, another important processed-vegetable producer, likewise did not report having an IPM program in 1989. Like many of the other States without vegetable programs, IPM funds have been focused on major field crops. Many Northeastern States have vegetable IPM programs even though they are not that important in total U.S. vegetable production (only New York is in the top 10 in vegetable receipts). However, some processed vegetable production and seasonal

Figure 6

Top six vegetable IPM-funded States

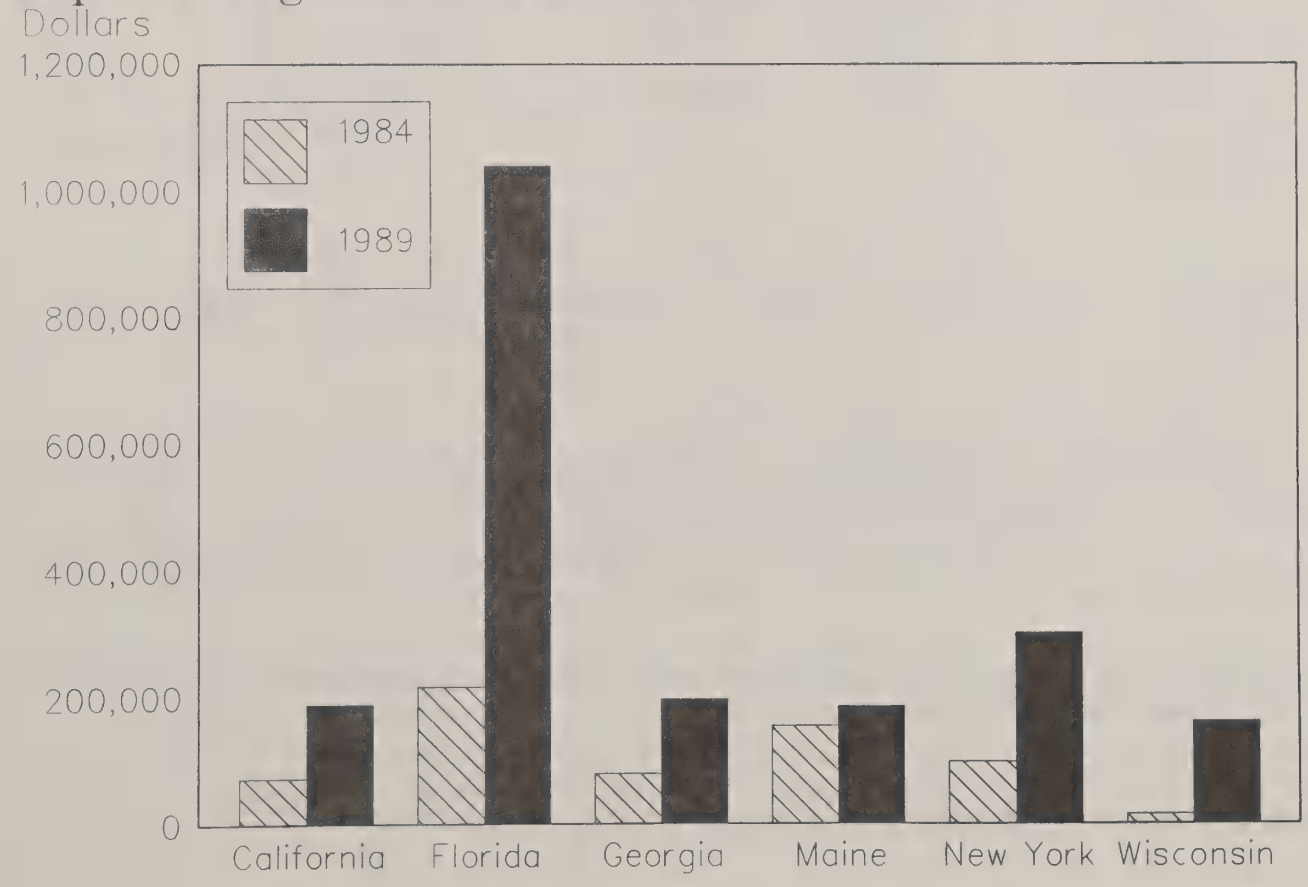


Table 3--IPM funding for the top 20 States ranked by vegetable cash receipts, 1989

Rank	State	Vegetable cash receipts	Total IPM funds	Share of funding by--		
				State	Federal Government	Industry
		1,000 dollars	*Dollars*	---------- *Percent* ----------		
1	California	3,704,837	187,100	0	0	100
2	Florida	1,545,012	1,039,000	5	9	87
3	Idaho	737,882	58,325	0	0	100
4	Washington	583,412	29,305	100	0	0
5	Wisconsin	354,237	160,000	19	0	81
6	Texas	349,866	20,000	100	0	0
7	Colorado	325,235	58,000	9	0	91
8	Arizona	320,390	NR	0	0	0
9	Michigan	320,213	NR	0	0	0
10	New York	310,399	299,285	11	0	89
11	Oregon	293,924	71,461	70	7	23
12	Minnesota	196,082	NR	0	0	0
13	Georgia	177,153	195,317	16	16	69
14	North Dakota	169,537	27,000	70	11	19
15	Maine	168,690	184,300	24	32	43
16	North Carolina	155,723	NR	0	0	0
17	New Mexico	149,601	NR	0	0	0
18	Nebraska	145,313	38,000	36	38	26
19	Ohio	145,043	17,050	94	0	6
20	New Jersey	112,416	129,660	15	67	17

NR = Not reported.
Data may not add due to rounding.

production for the fresh market is important in the Northeastern States, which tend to be actively involved in food safety issues. Also, there is less competition with field crops for IPM funds in these States.

Industry is the predominant funding source for IPM programs in most of the top vegetable States. However, 3 of the top 10 States (Washington, Texas, and Oregon) reported that most vegetable IPM programs were federally funded. The biggest vegetable-producing States, California and Florida, have a well-developed private industry that offers IPM services to growers. The number of IPM consulting firms may be harder to report in other States where the industry is less well developed.

Industry funding includes grower payments to private IPM consultants and firms, cooperatives and other grower organizations, and extension IPM programs. Grower payments to private IPM consultants and firms constituted 62 percent of total U.S. industry funds (table 4). Grower payments to cooperatives and other grower organizations constituted 17 percent of the total, while payments to Extension-sponsored programs and others were 5 and 15 percent.

Table 4--Industry funding of IPM

State	Total industry funding	Grower payments to--			
		Extension	Consultants	Cooperatives	Other
	Dollars	*Percent*			
Alabama	10,000	0	100	0	0
California	187,100	NR	NR	NR	NR
Colorado	53,000	0	38	11	51
Connecticut	35,900	3	0	0	97
Delaware	4,500	0	100	0	0
Florida	900,000	0	75	25	0
Georgia	134,800	1	2	0	96
Idaho	58,325	75	0	25	0
Massachusetts	21,466	10	0	0	90
Maryland	67,000	0	82	18	0
Maine	80,000	0	81	0	19
North Dakota	5,000	0	0	100	0
New Jersey	22,160	90	0	0	10
New York	265,285	4	66	8	22
Ohio	1,050	100	0	0	0
Oklahoma	14,000	0	100	0	0
Oregon	16,500	61	39	0	0
South Carolina	40,000	0	0	100	0
Wisconsin	130,000	0	100	0	0
U.S. total	1,858,986	5	62	17	15

NR = Not reported.

IPM Acreage, Consultants, and Clientele

Vegetable acreage under some level of IPM increased from 742,000 in 1984 to nearly 2 million acres in 1989 (table 5). These estimates include IPM acreage managed under Extension programs, private consultants and firms, cooperatives and other grower organizations, industry fieldmen, as well as growers and others influenced by extension recommendations. Management of IPM acreage ranges from minimal (monitoring a single pest, for instance) to intensive, where multiple insects, diseases, and weeds are monitored and resistant varieties, natural predators, crop rotations, and other nonchemical strategies are used.

States reported that IPM was used on 33 percent of the total vegetable acreage in 1989.[6] However, total IPM acreage is underestimated because some States did not report vegetable acreage affected by

[6]A small amount of the IPM acreage is double-counted, and USDA's estimate of total vegetable acreage does not include some minor vegetables under IPM programs.

Table 5--Acreage of major vegetables under IPM, 1984-89[1]

Commodity and State	IPM acreage						1989 total vegetable acreage[2]	1989 IPM acreage as a share of total acreage
	1984	1985	1986	1987	1988	1989		
	Acres							*Percent*[3]
Asparagus:								
Washington	23,000	27,400	27,400	34,000	34,000	30,000	33,000	91
Other	--	--	--	--	--	--	70,210	--
Total	23,000	27,400	27,400	34,000	34,000	30,000	103,210	29
Dry beans:								
North Dakota	26,000	115,500	160,500	181,500	176,500	187,000	500,000	37
Other	15,000	15,000	15,000	15,000	15,000	--	1,357,600	--
Total	41,000	130,500	175,500	196,500	191,500	187,000	1,857,600	10
Onions:								
Georgia	--	100	--	--	--	45	4,800	1
New York	10,000	13,366	8,172	11,266	17,970	7,770	13,200	59
Other	--	--	--	10,000	--	--	119,730	--
Total	10,000	13,466	8,172	21,266	17,970	7,815	137,730	6
Potatoes:								
Colorado	--	54,000	60,000	60,000	130,000	122,000	68,500	178
Delaware	--	--	--	--	1,300	2,800	7,700	36
Idaho	8,000	8,500	8,500	8,500	8,500	6,000	355,000	2
Maine	133,000	130,000	113,000	113,000	79,000	84,000	80,000	105
New York	16,000	10,505	13,214	31,200	34,546	34,422	30,000	115
Wisconsin	--	--	--	14,700	14,700	15,000	68,500	22
Other	3,000	18,700	1,350	1,620	--	--	694,400	--
Total	160,000	221,705	196,064	229,020	268,046	264,222	1,304,100	20
Sweet corn:								
Connecticut	2,000	3,597	6,546	2,557	4,272	2,482	4,800	52
New York	10,000	5,950	--	--	39,378	20,376	54,100	38
Ohio	--	--	--	--	371	271	11,500	2
Oregon	--	--	--	--	26,000	40,000	48,200	83
Other	8,000	5,157	6,556	16,379	14,718	8,595	564,250	2
Total	20,000	14,704	13,102	18,936	84,739	71,724	682,850	11
Tomatoes:								
California	272,000	271,500	271,500	262,440	291,600	262,440	328,400	80
Georgia	--	505	867	1,455	3,211	1,759	2,800	63
New York	--	--	--	--	--	1,993	4,600	43
South Carolina	5,000	1,000	1,500	--	--	2,000	3,700	54
Other	65,000	28,902	750	40,365	--	--	144,020	--
Total	342,000	301,907	274,617	304,260	294,811	268,192	483,520	55
Other	146,000	230,820	241,843	248,206	1,032,274	1,136,505	--	--
Total IPM acreage	742,000	940,502	936,698	1,052,188	1,923,340	1,965,458	5,900,570	33[4]

-- = Not available.

[1]Includes acres handled by Extension-sponsored programs plus those handled by private consultants, grower organizations, industry fieldmen, and growers and others influenced by Extension recommendations.

[2]National Agricultural Statistics Service (NASS), "Crop Production" and "Vegetables."

[3]Ratio may exceed 100 because some States report IPM acreage as handled by more than one source.

[4]May be high because of double-counted IPM acreage and low NASS estimate for total vegetable acreage.

nonfederally-funded IPM programs. California, the largest U.S. vegetable producer, reports IPM acreage only for tomatoes.

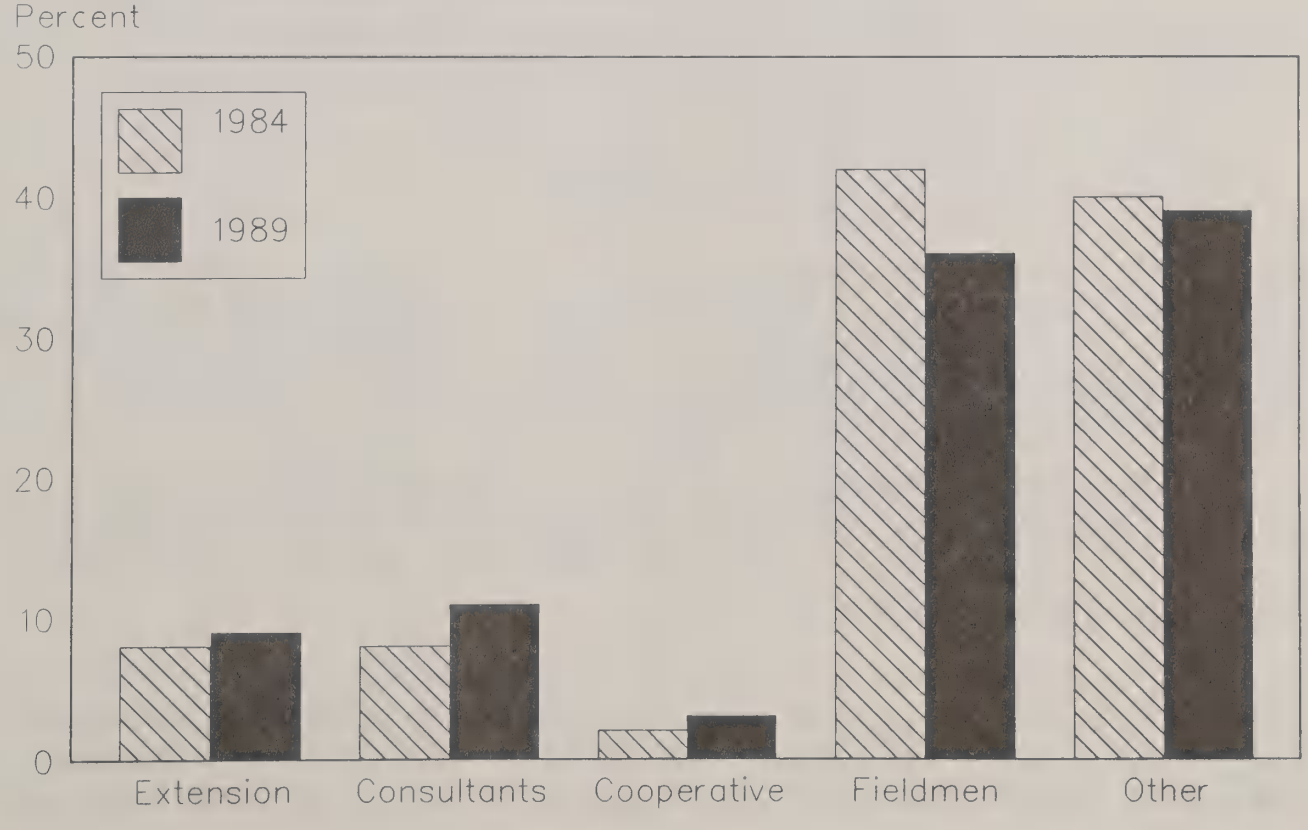
IPM acreage for some of the larger vegetable crops illustrate the differences in IPM adoption among States (table 5). New York, for example, had 59 percent of its onion acreage under IPM in 1989, while Georgia had only 1 percent. California had 80 percent of its 1989 tomato acreage under IPM, while the U.S. tomato IPM acreage was only 55 percent. These differences are partly a result of different priorities within States.

Overall, 10 percent of the U.S. dry bean acreage was under IPM. Acreage of dry beans under IPM in North Dakota, one of the biggest producers, increased from 26,000 in 1984 to 187,000 in 1989. Total potato acreage under IPM also increased during those years, from 160,000 to 264,222 acres. While Maine IPM potato acreage declined, total potato acreage in that State also declined.

For sweet corn, more than half a dozen primarily Northeastern States reported having IPM programs in 1989, although only 11 percent of the total sweet corn acreage was under formal IPM programs. For asparagus, only Washington reported IPM acreage. Washington, which accounts for more than a third of the total U.S. asparagus crop, reported that 91 percent of its acreage was under IPM.

In 1989, growers and others influenced by extension IPM recommendations, including growers who scout their own acreage, handled 39 percent of the IPM vegetable acreage, down from 40 percent in 1984 (fig. 7). Industry fieldmen, including advisors for contracted processing acreage as well as chemical companies' advisors, handled 37 percent of these acres, and were also down slightly from 42 percent in 1984.

Figure 7
Integrated pest management acreage under different providers



Extension-sponsored programs, private IPM consultants and firms, and cooperatives and other grower organizations handled 9, 11, and 3 percent of the 1989 IPM vegetable acreage. These groups had increased their share of the IPM vegetable acreage from 8, 8, and 2 percent in 1984.

The primary group handling IPM acreage differs significantly between different types of vegetable crops and different States. Some States have a highly developed private consulting industry or good Extension IPM programs. Others have well-established grower organizations providing IPM services for particular crops, while fieldmen or growers themselves are the most important source for IPM services in some States.

For example, all of the Wisconsin potato acreage is handled by private consultants, while 83 percent of the Idaho acreage is handled by grower organizations. Most sweet corn acreage in Ohio (80 percent) and half of Oregon's is under Extension-sponsored programs. Industry fieldmen are the primary source (84 percent) for New York's onion IPM acreage. Growers and others influenced by IPM handle 100 percent of Georgia's onion acreage, 77 percent of Maine's potato acreage, and most of Connecticut's sweet corn acreage.

The intensity of IPM use varies among these different groups handling vegetable acreage. IPM acreage handled by growers and others influenced by Extension may not be as intensively managed as those handled by Extension programs, consultants, grower organizations, and fieldmen.

According to a 1984-85 survey of Florida vegetable growers using IPM, growers using commercial IPM scouting recommendations reported using 80 percent fewer insecticides after adopting IPM, while growers who did their own scouting used only 50 percent less (*10*). Fungicide use was reduced by 31 percent for growers using commercial scouts and 17 percent for those doing their own scouting.

The Extension Service reports indicate that the number of professional scouts, as well as the number of producers trained annually in IPM techniques, increased since 1984 (fig. 8). The number of producers trained increased dramatically from 555 in 1984 to 4,419 in 1989, and the number of scouts trained more than doubled to 665. This is indicative of the increasing level of sophistication among growers interested in using IPM, and their need for more formal in-depth IPM training.

Conclusions

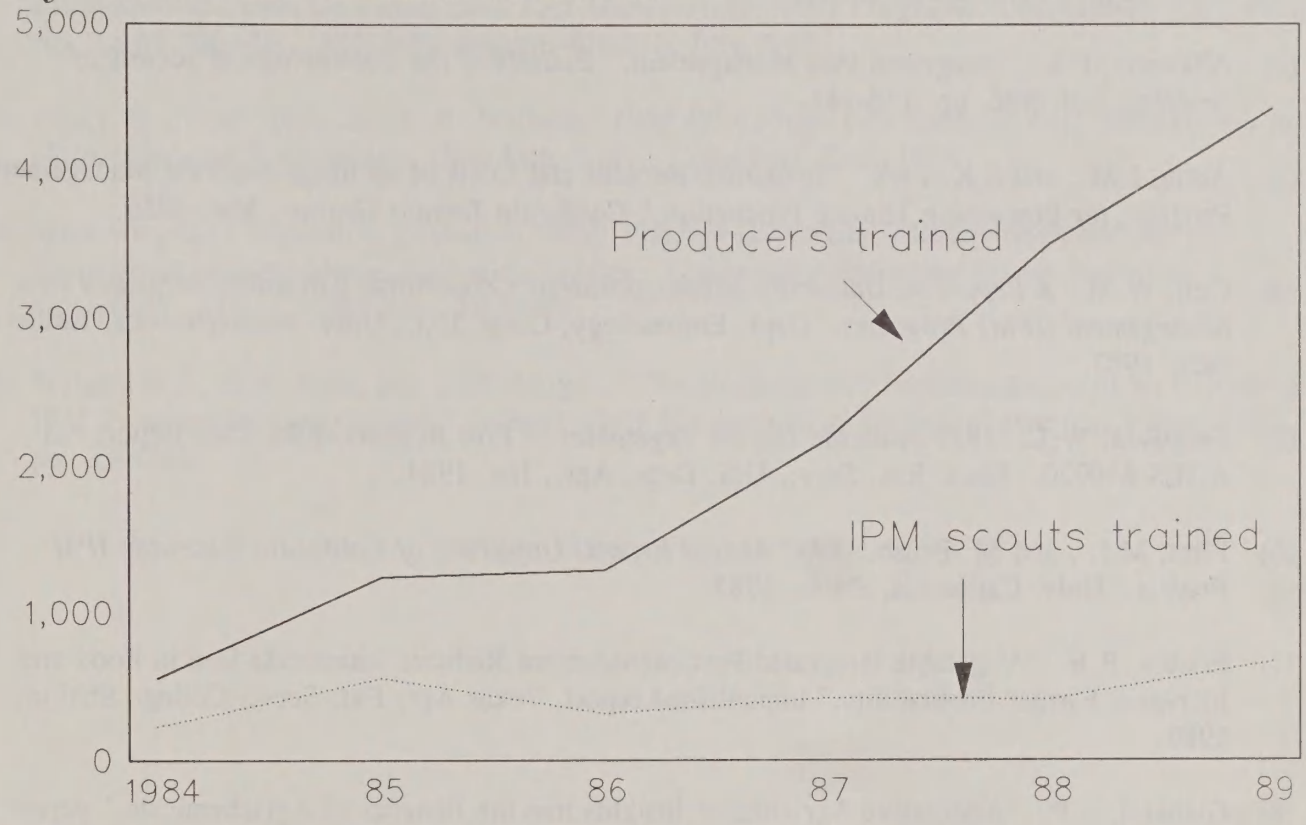
Vegetable IPM funding increased dramatically during the 1980's, according to an annual survey of State extension specialists. Although Federal funding has been virtually unchanged since 1984, State funding has tripled and industry funding has more than quadrupled. Industry IPM funding has increased for several reasons, including interest in reducing pesticide use, cutting expenses, and responding to public pressure regarding food safety concerns.

The lack of increased Federal funding, however, may be a problem for conducting the basic scientific research that industry's IPM guidelines are generally based on and for disseminating IPM information to growers. Also, research on the use of biological control is more dependent on Federal funding because its public good quality limits private research.

Vegetable acreage under IPM has also increased dramatically, rising from 742,000 in 1984 to nearly 2 million acres in 1989. Some level of IPM use was reported for 33 percent of the total vegetable acreage in 1989, and this estimate would be even higher if all nonfederally funded IPM programs were included. However, although there are IPM programs for some vegetable crops in most major

Figure 8

Integrated Pest Management Training by the Extension Service



producing States, many programs could be expanded to cover more pest problems and use additional IPM techniques.

Although most States indicate that vegetable IPM programs have reduced pesticide use in their State, and research on vegetable IPM also suggests reduced pesticide use, there is little pesticide use data to document change. The only vegetable crop for which a national pesticide use survey has been conducted since the late 1970's is potatoes. This survey showed that the 1988 potato acreage treated with insecticides and fungicides was down slightly from 1978, while acres treated with herbicides were up slightly.

During the next century, pest control solutions that could eliminate chemical pesticides may become available. The concepts for these solutions include "the use of Agrobacterium-mediated transformation in a pathogen-derived resistance approach; protoplast fusion and somatic hybridization; selection of disease resistance at the cellular level; hypovirulence; and superactive biocontrol agents" (*11*). However, State and Federal regulations on pesticide use are already tightening, and IPM programs that reduce pesticide use will continue to be important during the coming decades.

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